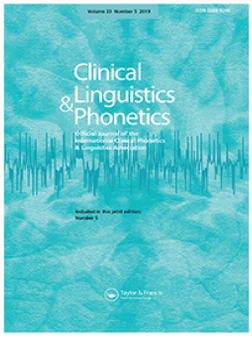

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Clustering of disfluencies in typical, fast and cluttered speech

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ABSTRACT

Cluttering is a fluency disorder which can be characterised by excessive disfluencies. However, the low number of studies dealing with the analysis of disfluencies in cluttering show contradictory results. The aim of this article is to analyse disfluency clusters in cluttered, fast and typical speech. Frequency of all disfluency clusters and those complex disfluencies which contain more than two constituents were analysed. The number and types of the constituents of complex disfluencies and the reason of their occurrence were analysed in detail.

Results show that complex disfluencies occurred the most frequently in cluttered speech, and the least frequently in exceptionally rapid speech (ERS). Persons who clutter (PWC) had more and much longer complex disfluencies than typical speakers. Complex disfluencies which suggest difficulties in linguistic formulation occurred in cluttering significantly more times than in typical speech. The results bring us closer to understanding why there are perceptually more disfluencies in cluttered speech than in typical one. In addition, they also seem to strengthen the notion that cluttering is a language disorder.

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Cluttering; exceptionally rapid speech; disfluency clusters; linguistic formulation

Introduction

Cluttering is a speech fluency disorder. According to its most widely accepted definition, namely the Lowest Common Denominator definition (St. Louis & Schulte, 2011, p. 241–242), it can be characterised by excessive disfluencies. However, the low number of studies dealing with the analysis of disfluencies in cluttering show contradictory results. There are studies (e.g. Oliveira, Broglio, Bernardes, & Capellini, 2013) which show that persons who clutter (PWC) produce disfluencies more frequently than typical speakers, while others (Bakker, Myers, Raphael, & St. Louis, 2011; Bóna, 2018; Myers, Bakker, St Louis, & Raphael, 2012) have not found significant difference between the two groups in the frequency of disfluencies. The contradictory findings of the literature can be explained in various ways. On the one hand, frequency of disfluencies is influenced by individual characteristics of the speaker both in typical and atypical speech (Shriberg, 2001). On the other hand, the speech task also has an effect on (dis)fluency (van Zaalen et al. 2009a). Third, it might be affected by language-specific features too (Shriberg, 2001). The possible cause of an increase in more frequent occurrence of disfluencies could be that PWC do not have enough time for linguistic planning (van Zaalen et al. 2009b). However, if they slow down their speech, it becomes more fluent (Bóna, 2012).

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Other than PWC, there are also persons who produce similarly fast speech, but do not produce more disfluencies than typical speakers: they are persons who exhibit exceptionally rapid speech (ERS) (Bakker et al., 2011; Bóna, 2016). Bakker et al. (2011, p. 47) define ERS as speech occurring faster than normal, but which does not show 'specific clinically significant characteristics of speech fluency'. This means that with regard to speech rate, ERS are similar to PWC. With regard to speech planning, they are more similar to typical speakers (Bakker et al., 2011).

A lack of difference in the observed numbers of disfluencies between PWC and typical speakers may be explained with the Cluttering Spectrum Hypothesis (CSH) (Ward, 2006). According to CSH, there is a big overlap in the symptoms of speech of typical speakers and PWC. Typical speakers produce characteristic features of cluttering too. As cluttering is a multidimensional disorder, there are other factors in addition to the frequency of disfluencies (fast or irregular speech rate, poor speech intelligibility, inappropriate prosody, etc.) which can affect its perception. Occurrence of excessive disfluencies is a possible but not obligatory characteristic of cluttering (St. Louis & Schulte, 2011, p. 241–242; Myers et al., 2012). A related possibility is that severity of disfluency while not different in a quantitative sense, could appear more severe perceptually because of the types, and locations, where these disfluencies occur.

Disfluencies often occur in disfluency clusters. Clustering of disfluencies means that two or more disfluencies occur on the same word or adjacently. This clustering can be decisive in the perception of disfluencies in cluttering and in the diagnosis of the disorder, similarly to stuttering (Hubbard & Yairi, 1988; LaSalle & Conture, 1995). Examples for two-elements disfluency clusters are the following (from LaSalle & Conture, 1995): *I-l-l-you were going, I was I was um going.*

There are various theories on occurrence of disfluency clusters. Because they are much more frequent in stuttering than in typical speech (Hubbard & Yairi, 1988; LaSalle & Conture1995), theories are connected to this disorder. Disfluency clusters might appear because of the anxiety about the occurrence of a single disfluency (Still & Griggs, 1979). They might appear because of a problem of the speech motor system (Hubbard & Yairi, 1988). They can be traced back to the covert repair hypothesis (Postma & Kolk, 1993) or in more complex structures to a linguistic planning problem (Logan & LaSalle, 1999). According to Wexler and Mysak (1982), clusters containing stuttering-like disfluencies (SLD) (SLD-SLD clusters) show problems in the motor component of speech, while in clusters containing other disfluencies (OD) the linguistic factor could be more operative. According to the EXPLAN theory (Howell & Au-Yeung, 2002), there are two main types of disfluencies: stalling and advancing. Stalling disfluencies (OD: phrase repetitions, whole-word repetitions and interjections which include filled and abnormally long silent pauses) give time for planning the next word or utterance. Advancing disfluencies (mainly SLD: part-word repetitions, prolongations, broken words and OD: idea abandonment, phrase revisions) occur on different words. That is, advancing disfluencies occur in SLD-SLD clusters, stalling disfluencies occur in OD-OD clusters, while both components are present in mixed clusters (Robb, Sargent, & O'Beirne, 2009).

Complex disfluencies are those in which not only two disfluencies are clustered but several disfluencies might also appear adjacently. These complex disfluencies are a series of disfluencies in succession (Gósy, 2012b; Heeman, McMillin, & Yaruss, 2006; Robb et al., 2009; Shriberg, 1994). Clusters containing more than two disfluencies

indicate more severe speech planning difficulties than disfluencies as singletons or clusters of two disfluencies. Gósy (2012b) analysed not only complex disfluency clusters but also examples in which there were a maximum of two fluent words between two disfluencies in a coherent context as a series of disfluencies. According to the results, series of disfluencies occur in typical spontaneous speech quite rarely, and they can be categorised in three types: 1) In case of a series of disfluencies which indicate difficulties in message generation, speakers do not know what to say or how to continue. 2) In case of a series of disfluencies which indicate difficulties in linguistic planning, speakers know what they want to say but there are difficulties in language formulation. 3) In case of the mixed type, there are difficulties with message generation and language formulation too. Although the main question about cluttering is whether it is a language or motor problem (e.g. Van Zaalen-Op't Hof et al., 2009a, 2009b; Ward, 2011), it is worth analysing how the above mentioned types of series of disfluencies occur in cluttered speech since PWC have self-monitoring, attention and other communication problems (Van Zaalen & Reichel, 2015), and they do not correct communication breakdowns (Daly, 2006).

Some authors analysed the occurrence of certain types of disfluencies in cluttering and typical speech (e.g. Myers et al., 2012; Oliveira et al., 2013). According to the results, the most frequent types of disfluencies are the same in both groups (Myers et al., 2012). However, Brazilian Portuguese PWC produced more than twice as many interjections, revisions and unfinished words, and seven times more word repetitions than typical speakers (Oliveira et al., 2013). Myers et al. (2012) compared American English PWC and control speakers. They found significant differences between the two groups only in the frequency of revisions in clusters and word repetitions in clusters. Bóna (2018) found in Hungarian speakers that typical speakers produced significantly more fillers as singletons and prolongations as singletons, and significantly less part-word repetitions than PWC.

Frequency of disfluency clusters might indicate the severity of cluttering (Myers, St. Louis, and Faragasso 2008; Myers et al., 2012). Myers and Louis (1996) analysed the speech of two PWC. They found that there were four times more disfluency clusters in the speech of PWC with more severe cluttering than in the speech of PWC with less severe cluttering. Types of disfluencies were not influenced by the severity of cluttering. The most frequent cluster constituents were interjections, revisions and unfinished words. Myers et al. (2012) compared the speech of 18 PWC and 20 typical speakers. Their results showed that PWC produced much more clusters than typical speakers. At the same time, the same types occurred in clusters in both groups. Bóna (2018) did not find any significant differences between PWC and typical speakers in the occurrence of disfluency clusters. Although PWC produced more disfluency clusters on average than typical speakers, there were great individual differences between the speakers in both groups. Therefore, there was not any significant difference between the two groups in frequency. However, there is no information in the literature about the occurrence of complex disfluencies in cluttering.

The present study addresses two main questions: First question of this study addresses the frequency of complex disfluencies in cluttered, fast and typical speech. Also addressed is the proportion of all disfluency clusters that can be characterised as complex clusters and potential differences between the participants groups.

It was hypothesised that 1) complex disfluencies occur more frequently in speech of PWC than in speech of typical speakers or ERS. 2) There would not be any differences between typical speakers and ERS in the frequency of complex disfluencies. 3) There will be differences between the three groups in the number of constituents of complex disfluencies. 4) Complex disfluencies related to both message generation and language formulation will be more frequent in PWC than in the other two groups.

Procedure

Participants

Tewnty-seven speakers participated in the analysis: nine PWC, nine ERS and nine typical speakers. In the three groups there were gender- and age-matched speakers. In all groups there were five males and four females. All speakers were aged between 20 and 32. (Mean age of PWC was 26.1, SD: 3.9. Mean age of ERS was 24.8, SD: 3.9. Mean age of typical speakers was 24.7, SD: 3.5.) All of them were native Hungarian speakers with normal hearing, and they had at least 14 years of education.

PWC and ERS were recruited by acquaintances and speech therapists for the study. ERS were people who know that they speak faster than average. Control speakers were university students who participated in the recordings of BEA Hungarian Speech Database (Gósy, 2012a). All participants volunteered for the tasks. Two experts in fluency disorders, a speech-language pathologist and a linguist specialised in fluency disorders, determined the diagnostic decisions independently of each other. They classified the speakers based on the recordings in three groups. Their rate of agreement was 100%. Like in Bakker et al. (2011), subjects were classified as ERS, if their speech rate was perceived to be fast and they did not show any other features of disordered speech. Subjects were classified as PWC, if they had perceptually rapid and/or irregular speech rate and their speech was characterised at least by one of the following (Bakker et al., 2011): (1) Excessive disfluencies (the majority of them were non stuttering-like) and/or (2) specific articulation characteristics (which manifested in coarticulated speech or omissions of sounds and syllables; but it was not dyslalia, for example; Bakker et al., 2011; van Zaalen- op 't Hof et al. 2009a).

In PWC's group, speakers were pure clutterers. They did not have any comorbid speech and language disorders and they did not express self-reported issues related to cognition of a psychiatric nature. Speech therapists determined that they were PWC who did not stutter. They also did not have a history of stuttering in the past. All of them were aware of their speech problems (this is often indicated to them by their speech partners) and they considered themselves to be PWC.

Speech rate (the total number of syllables divided by total speaking time including pauses) and articulation rate (the total number of syllables divided by total speaking time without pauses) were measured objectively (Table 1). They were calculated on the basis of the number of syllables that should have been realised (van Zaalen-op 't Hof et al. 2009a). In speech rate, there was significant difference between the groups: according to UniANOVA (used because of the normal distribution of the data) $F(2, 25) = 8.674$; $p = 0.001$; $\eta^2 = 0.420$; Tukey post hoc test showed significant difference between controls and ERS: $p = 0.001$, and between controls and PWC: $p = 0.024$. In articulation rate, there

Table 1. Speech rate and articulation rate of the subjects (mean and range) (in syllables per second).

	Typical speakers	ERS	PWC
Speech rate	4.1 (3.1–5.1)	5.5 (4.7–7.1)	5.1 (4.6–5.7)
Articulation rate	5.8 (4.8–6.9)	7.3 (6.2–8.5)	6.8 (6.2–7.2)

was significant difference between the groups: $F(2, 25) = 11.806$; $p < 0.001$; $\eta^2 = 0.496$; Tukey post hoc test showed significant difference between controls and ERS: $p < 0.001$, and between controls and PWC: $p = 0.015$. There were not any significant differences between ERS and PWC neither in speech rate nor in articulation rate.

Material

Spontaneous speech was recorded from each participant. They spoke about the same topics: education, work, hobby, family. The interviewer left the participants to speak freely. She asked them only when they needed a question for the continuation. Speech samples were recorded in a soundproof chamber. Three hundred syllables of speech were analysed from each speaker. The 300 syllables were selected from the middle of the speech samples because this was the part where speakers were already warmed up and they were quite comfortable in speaking. This is more than 200 syllables recommended by SDA (Campbell& Hill 1994).

Method

Speech samples were written orthographically. Disfluency clusters were annotated in each transcription (singletons were not analysed in this study). In disfluency clusters, the following types of disfluencies occurred (based on Roberts, Meltzer, and Wilding 2009, and Tetnowski and Scott 2010): interjections, whole-word repetitions, part-word repetitions, phrase repetitions, prolongations and revisions. Type of interjections can be divided in two subtypes which were counted separately, too: (1) filled pauses which are sounds without meaning (Fletcher, 2010), the most frequent types are *ö, m öm, öh* in Hungarian (Horváth, 2010) and (2) filler words which are interjections of whole words (Table 2). There were not any blocks (tense pauses) in the speech samples. The phenomena in which two or more disfluencies occurred in the same word or adjacently were considered disfluency clusters. Prolongations on interjections (filled pauses) were not counted (as in Roberts at al. 2009). Frequency values refer to the number of occurrences in the analysed 300 syllables.

After that, complex disfluencies (clusters containing more than two constituents) were analysed in detail. The number and types of their constituents were analysed. With the examination of context, the presumed causes of complex disfluencies were defined, too. Similarly to Gósy (2012b), there were two main types of complex disfluencies: difficulty in message generation and difficulty in linguistic planning. In case of difficulty in message generation, disfluencies occurred in syntactic boundaries, and the content of the original utterance (the text before the complex disfluencies) did not refer to the continuation, and the content of the continuation after the complex disfluencies linked loosely to the original utterance. In case of difficulty in linguistic planning, there was an error repair in the complex disfluencies, or the speaker did not find the arguments or the following word, etc.

Table 2. Types of disfluencies based on Roberts et al. (2009) and Tetnowski and Scott (2010).

Disfluency type	Definition	Typical or stuttering-like disfluency
Interjection	Any sound, syllable or extraneous word which does not contribute meaning to the sentence.	Typical disfluency
Part-word repetition	A sound or syllable said more than once with no intervening meaningful syllable or word.	Stuttering-like
Word repetition	A word said more than once with no intervening meaningful syllable or word.	Typical disfluency (in adults' speech)
Phrase repetition	More than one word said more than once with no intervening meaningful syllable or word.	Typical disfluency
Revision	Instances when the speaker corrects an error.	Typical disfluency
Prolonged sounds	Any sounds considered longer than normal.	Stuttering-like

Statistical analyses (Kruskal–Wallis-test, Mann–Whitney-test, UniANOVA and Tukey post hoc test, depending on the distribution of the data) were carried out by SPSS in 95% confidence level. Tests were conducted two way.

Reliability

All calculations and ratings were carried out twice by the author, two weeks apart. The results of the two analyses were the same in 100% of the cases.

Results

Frequency of disfluency clusters

First, frequency of disfluency clusters was analysed. There were 61 disfluency clusters in PWC's, 5 in ERS's and 43 in typical speakers' speech. Table 3 shows the frequency of the total number of disfluency clusters. Six ERS (66,7%) did not produce disfluency clusters at all. Overall, most clusters occurred in the speech of PWC, but there was a speaker among them who produced only two disfluency clusters. At the same time, there were PWC who produced 11 and 13 disfluency clusters. Among typical speakers, there were two persons who did not produce disfluency clusters at all. The speaker who demonstrated the greatest number of disfluency clusters had 11 of them. Statistical analysis showed significant difference between the groups: according to UNIANOVA $F(2, 25) = 9.031$; $p = 0.001$; $\eta^2 = 0.429$. Tukey post hoc test showed significant difference between ERS and typical speakers ($p = 0.028$) and between ERS and PWC ($p = 0.001$) in the total number of disfluency clusters. There was not a significant difference ($p = 0.580$) between typical speakers and PWC in the frequency of all disfluency clusters.

Table 3. Frequency of occurrence of disfluency clusters and complex disfluencies in 300 syllables in the speech of typical, PWC and ERS speakers.

	Typical		PWC		ERS	
	Mean	SD	Mean	SD	Mean	SD
Number of all disfluency clusters	4.8	4.2	6.8	3.5	0.6	0.9
Number of all complex disfluencies	0.8	0.7	2.6	1.8	0.0	0.0
Proportion of complex disfluencies in all disfluency clusters (%)	24.5	31.5	36.2	24.3	0.0	0.0
Number of all complex disfluencies containing three disfluencies	0.6	0.5	1.3	1.0	0.0	0.0
Number of all complex disfluencies containing more than three disfluencies	0.8	0.7	1.2	1.5	0.0	0.0

Table 4. Examples of complex disfluencies (FIL = filled pause; SIL = silent pause) (disfluencies are highlighted in bold).

Number of example	Speaker	Example
Complex disfluencies which suggest difficulties of message generation		
1)	PWC	**FIL** SIL **hát igazából** a**zz**t SIL **azt FIL** SIL szerettem volna megnézni hogy SIL **hogy FIL** SIL **hát FIL** SIL elsősorban ilyen pszicholingvisztikai szempontból SIL tehát hogy **FIL** SIL **FIL pillanat** SIL **tehát** SIL **FIL** SIL hogy SIL igazából a engem az SIL az SIL az érdekelt 'FIL SIL well actually I wanted to have a look at that SIL that FIL SIL that SIL that FIL SIL so FIL SIL first of all from a psycholinguistic aspect SIL so that FIL SIL FIL wait a second SIL so SIL FIL SIL so SIL a actually I wanted to SIL to SIL to know'
2)	Typical speaker	én egy SIL gimnáziumba tanítok SIL magyart és énekzenét SIL így **hát FIL** SIL **FIL** a nyelvészettel nem csak hobbiszinten foglalkozom 'I SIL teach in a grammar school SIL Hungarian language and literature and music SIL so that FIL SIL FIL for me linguistics is not only a hobby'
Complex disfluencies which suggest difficulties of linguistic formulation		
3)	PWC	beszéltem FIL SIL egy **FIL** SIL **FIL** SIL **egy e** SIL **egy honvédelmi** SIL honvéd ezredessel 'I talked to FIL SIL a FIL SIL FIL SIL a a SIL a national defence SIL home-defence colonel'
4)	Typical speaker	ma már **rá FIL a akcióantr** vagyis **FIL** alkalmazott antropológia SIL tehát SIL eredetileg én ami ami engem érdekelne FIL SIL az kutatás 'today apr FIL a actionantr or FIL applied anthropology SIL so SIL originally I what what I an interested in FIL SIL is research'

Frequency and proportion of complex disfluencies

Frequency of complex disfluencies was calculated to analyse if they occur more frequently in the speech of PWC, than in the speech of typical speakers or ERS. With regard to the frequency of complex disfluencies, the statistical analysis showed a significant difference between the groups: according to UNIANOVA $F(2, 25) = 12.448$; $p < 0.001$; $\eta^2 = 0.509$. Tukey post hoc test showed significant difference between PWC and typical speakers ($p = 0.007$) and between PWC and ERS ($p < 0.001$) in the frequency of complex disfluencies.

The speech of ERS did not contain complex disfluencies. PWC produced more than three times as many complex disfluencies as typical speakers (Table 3). There were speakers in both groups who did not produce any complex disfluencies. In the group of PWC, there was only one such speaker, while in the group of typical speakers there were three.

In the speech of PWC, more than one third of the disfluency clusters were complex disfluencies, while in the speech of typical speakers, they were only one quarter (Table 3). Kruskal–Wallis-test showed significant difference between the groups in the proportion of complex disfluencies in all disfluency clusters: $\chi^2 = 13.821$; $p = 0.001$. Since the speech of ERS did not contain complex disfluencies, the speech of PWC and typical speakers was also compared with Mann–Whitney-test with corrected p-value. Results show that there were not any significant differences between the two groups perhaps because of the great variability of the data.

Constituents of complex disfluencies

The number of constituents of complex disfluencies was also analysed to see the possible differences between the groups. Most of complex disfluencies contained three constituents: 52.2% of cases in the speech of PWC, 71.4% of cases in the speech of typical speakers.

Kruskal–Wallis-test showed significant difference between the groups in the frequency of the complex disfluencies containing three or more elements: $\chi^2 = 15.038$; $p = 0.001$. However, this difference was due to the group of ERS. Although the average number of the complex disfluencies containing both three elements and more than three elements was bigger in PWC than in typical speakers, there was not any significant difference between the two groups. In the speech of PWC, complex disfluencies occurred containing four, five and six components. In the speech of typical speakers, complex disfluencies occurred containing four and six components.

Types of complex disfluencies

Finally, instances of complex disfluencies were categorised in subtypes to be able to analyse the reason of their occurrence. With regard to the analysis of context, mixed type of complex disfluencies were not found in the material. If all complex disfluencies are considered 100% in each group, proportions of complex disfluencies which suggest difficulties with message generation and those which suggest difficulties of linguistic encoding were similar in the groups of PWC and typical speakers. The proportion of complex disfluencies which suggest difficulties with message generation was 39% in PWC, 43% in typical speakers. The proportion of complex disfluencies which suggest difficulties of linguistic encoding was 61% in PWC and 57% in typical speakers.

There was not any significant difference between the groups in the frequency of complex disfluencies due to the difficulty with message generation, although three times as many of complex disfluencies appeared in the cluttered than in the typical speech. The reason for this is that among both PWC and typical speakers, there were five and six speakers who did not produce this behaviour (and nobody produced it in the group of ERS). Example (1) from a PWC and example (2) from a typical speaker show complex disfluencies which suggest difficulties with message generation (Table 4). In Example (1), there are three complex disfluencies, and the utterances between them contain two disfluencies as singletons, too. In the first complex disfluency there are two filled pauses, two filler words, one prolongation and one whole-word repetition. In the second complex disfluency there are one whole-word repetition, two filled pauses and one filler word. In the third complex disfluency, there are three filled pauses and two filler words. In Example (2), there is a complex disfluency containing three elements: one filler word and two filled pauses.

Complex disfluencies which suggest the difficulty of linguistic planning occurred in all PWC except for one speaker, while they occurred only in three typical speakers. With regard to the total number, PWC produced three times as many complex disfluencies than typical speakers. (ERS did not produced this type at all.) According to the statistical analysis, there was significant difference between the groups in the occurrence of complex disfluencies which suggest the difficulty of linguistic planning (Kruskal–Wallis-test: $\chi^2 = 13.876$; $p = 0.001$; Mann–Whitney-test considering only the groups of PWC and typical speakers: $Z = -2.212$; $p = 0.040$). Example (3) from a PWC and example (4) from a typical speaker show complex disfluencies which suggest difficulties with linguistic formulation. Example (3) contains two filled pauses, two whole-word repetitions, one part-word repetitions and one revision, but before the complex disfluency, there are a filled

pause and a silent pause. Example (4) contains two false starts, one part-word repetition and one filled pause, but there is a disfluency in every two words in wider context.

Types of disfluencies occurring in the two functions of complex disfluencies (difficulties in message generation and difficulties in linguistic formulation) were analysed. PWC produced more interjections (both filled pauses and filler words), word-repetitions, prolongations and revisions in the complex disfluencies. Except for interjections (mainly filler words), each type of disfluencies occurred more frequently in complex disfluencies which suggest difficulties in linguistic formulation. Phrase repetitions, part-word repetitions and revisions occurred only in complex disfluencies which suggest difficulties in linguistic formulation (Figures 1 and 2). Filled pause occurred in the greatest proportion in both speaker-groups and both types of complex disfluencies. Filler words and word-repetitions occurred in greater proportion in both types of complex disfluencies in PWC than in typical speakers (Figure 3).

Discussion and conclusion

In this study, the frequency and other characteristics of disfluency clusters and complex disfluencies were examined in cluttered, fast and typical speech. It was hypothesised that PWC produce complex disfluencies most frequently (1st hypothesis), while there would not be a significant difference between typical speakers and ERS in the frequency of complex disfluencies (2nd hypothesis). It was hypothesised that ERS resemble PWC only in articulation rate, as regards speech planning processes, they are more similar to the typical speakers. Results show that PWC indeed produced complex disfluencies the most frequently, but ERS differed significantly from typical speakers. This means that the first hypothesis was confirmed, but the second was not. In the speech of ERS, even disfluency clusters containing two components occurred quite rarely and its frequency was significantly lower than its frequency in the other two groups. Results of ERS might be explained by the presupposition that in the background of being able to speak very rapidly, there might be very fast and accurate speech planning processes. If

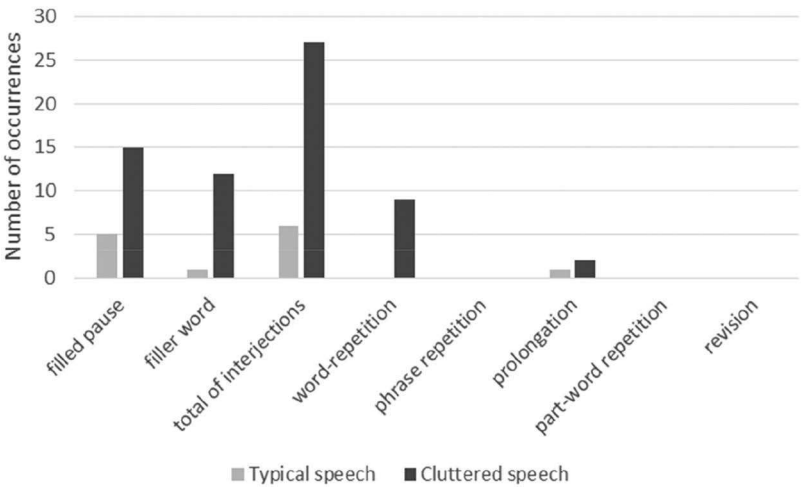

Figure 1. Number of occurrences of types of disfluencies in the complex disfluencies which suggest difficulties of message generation.

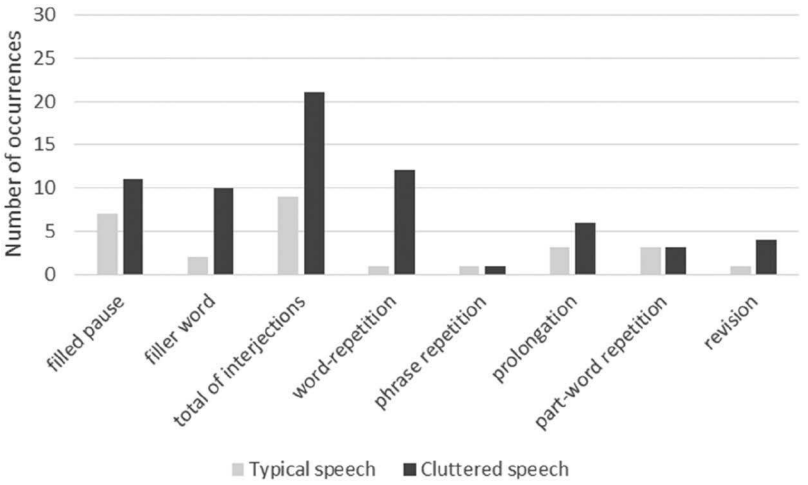

Figure 2. Number of occurrences of types of disfluencies in the complex disfluencies which suggest difficulties in linguistic formulation.

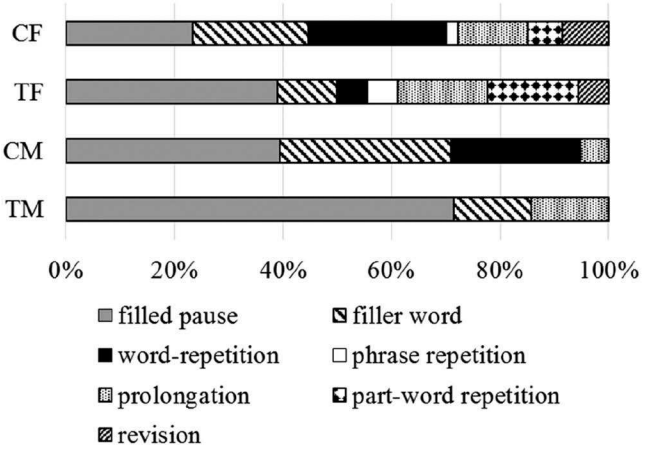

Figure 3. Ratio of types of disfluencies in the complex disfluencies of different functions (T = Typical speakers, C = PWC; M = Difficulties in message generation, F = Difficulties in language formulation).

speech planning processes of ERS worked with a lot of mistakes, there would be more pauses and disfluencies in their speech, and probably listeners would not perceive their speech so rapid.

The increased number of complex disfluencies found among PWC indicates that they really have more serious difficulties in speech planning and production than typical speakers. If typical speakers have speech planning problems, they can generally resolve them during the pronunciation of just one disfluency. If PWC have speech planning problems, they produce multiple series of disfluencies while they can resolve the apparent speech planning issues during the disfluencies. Literature shows that the number of the total of disfluencies is similar to that of typical speakers (Myers et al., 2012), but it seems that the position of their occurrence (as regards clusters) is different. The serial occurrence of disfluencies (i.e. more frequent complex disfluencies) could be an explanation for why these phenomena are more apparent to listeners who feel that there are more disfluencies in cluttered than in typical speech. The composition of clusters, complex

disfluencies and the type of constituents may be the reason why we perceive that there are more disfluencies in cluttered speech.

It was assumed that there will be a difference in the number of components of complex disfluencies between the speakers' groups (3rd hypothesis). Both PWC and typical speakers produced complex disfluencies of three to six constituents. Thus, there was not any difference between the two groups in length (the 3th hypothesis was not confirmed). However, there was a difference in the proportion of certain types of disfluencies in complex disfluencies. Myers et al. (2012) found significant differences between the two groups only in the occurrence of revisions in clusters and word repetitions in clusters. Although statistical analysis was not carried out in the present study due to the small number of elements, except for phrase repetitions and part-word repetitions, each type of disfluencies occurred in higher number in PWC than in typical speakers. (PWC had more and much longer complex disfluencies than typical speakers.) Phrase repetitions and part-word repetitions are quite rare in speech. The latter is stuttering-like which is not typical for either typical or cluttered speech.

Complex disfluencies might be categorised into two major types, depending on their behavioral characteristics. There was not any difference between the two groups in the frequency of complex disfluencies which suggest difficulties with message generation. This might mean that although speech planning is more difficult in cluttering, PWC know what they want to say.

In both groups there were more complex disfluencies which suggest difficulties in linguistic formulation. This type occurred in PWC significantly more times than in typical speakers. The fourth hypothesis was partially confirmed. Difficulties in linguistic formulation in cluttering were described in several studies (Van Zaalen-Op't Hof et al., 2009b; Bretherton-Furness & Ward, 2012; Myers & Bakker, 2014). These present results confirm and add new data to these findings.

The results, on the one hand, might contribute to the diagnosis of cluttering. In addition, secondly, bring us closer to understanding why there are perceptually more disfluencies in cluttered than in typical speech. As mentioned above, the higher frequency of complex disfluencies might give the impression that disfluencies are more frequent in cluttering. In addition, these results also seem to strengthen the notion that cluttering is a language disorder.

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Declaration of interest

I hereby declare that I have no financial or personal relationships with other people or organisations that could inappropriately influence (bias) the work reported in this article. I have no affiliation with any organisation with a financial interest, direct or indirect, in the subject matter or materials discussed in the manuscript that might affect the conduct or reporting of the work submitted.

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